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ABSTRACT

This review of articles and facts about microcomputers focuses on the development of hardware and software and the use of microcomputers in education, particularly rural education. In addition to presenting a brief history of microcomputers, the review presents information regarding the costs and brands of microcomputers; the development, use, research, and success of computer-assisted instruction; classroom uses of microcomputers (scheduling, problem-solving, graphics, interactive instruction); computer literacy for teachers and students; microcomputer trends; software development and design; characteristics of good software; criteria for hardware selection; and implications of microcomputer development for the future. Among the many articles quoted are "Microcomputers in Today's Schools: An Administrator's Handbook," by the Northwest Regional Education Laboratory; "The Resource Approach to the Analysis of Educational Project Cost," by the Department of Health, Education, and Welfare; "Microcomputers in Education: The State of the Art," by Gerald T. Gleason; "Microcomputers in Schools: Promise and Practice," by Bruce Kelsh and John Lindelow; "Powerful Ideas," by Cindy Tursman; and "The Information Rich Economy: Exploiting an Infinite Resource," by Robert Hamrin. (SB)

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THE IMPACT OF MICROCOMPUTERS ON RURAL SCHOOLS

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THE IMPACT OF MICROCOMPUTERS ON RURAL SCHOOLS

Frank A. Smith, New Mexico State University

The American Council on Rural Special Education has found that rural schools constitute 67 per cent of all schools in the U.S. and enroll 33 percent of all school children. Among their important findings the group made a recommendation that relates directly to the use of microcomputers.

States must investigate and support cooperative efforts between districts and cost-effective and efficient technology and communications systems. To introduce computers into their classrooms, rural educators must also have access to corporate gifts of hardware and software, and be in a position to provide inservice programs for teachers and staff members."

In this paper, I am going to look briefly at the history of microcomputers, touch upon the estimated extent of use in education, tell you some ways to identify quality software, inquire about the appeal of games, point out some of the ways that micros are being used today, discuss computer literacy, inservice training for teachers, name some organizations that can help you become informed and organized, and look into the future.

A look into the past:

1642 - Blaise Pascal, (Fr.) invents a mechanical adding and subtracting machine. A modern adaptation is a car odometer.

1671 - Gotfried Wilhelm Leibnitz - designs a mechanical multiplying and dividing machine.

1834 - Charles Babbage (English) designs the advanced and complex Analytical Engine. It anticipated the modern computer, even to the point of running on programs punched on paper tape. It could not be built with technology then available.

1936 - Konrad Zuse (Germany) designed an electronic digital computer. Built in 1941, called the Z3, it used relays to perform calculations.

1944 - IBM builds the Mark I computer for Harvard University, "The Automatic Sequence Controlled Calculator." It used gears and relays, not vacuum tubes. It was slow. It took 0.3 sec to add/subtract, 6 sec. to multiply, 11.4 sec. to divide. It was 51 ft. long, 8 ft. high, and weighed 5 tons.

1943 - 1946 - The University of Pennsylvania designs the ENIAC, "Electronic Numerical Integrator and Computer." the first all electronic computer. It weighed 30 tons, used 19,000 tubes per year, and required 200,000 watts of power.

1948 - The transistor is invented and starts to replace hot, power hungry vacuum tubes by 1959. The computer can now be made smaller, cheaper and more reliable.

1960's - transistor companies perfect the Integrated Circuit (IC), complete electronic circuits with a dozen or more parts on the surface of small chips of silicon. IBM produced the system 370 in the 1970's.

1965 - Digital Equipment produced the first minicomputer, the PEP-8. It was as high as a 2-drawer file cabinet and cost only $18,000.00 - a bargain.

1971 - Intel Corporation produces the first microprocessor. A complete CPU on a silicon chip smaller than a key on a pocket calculator. Used in calculators, microwave ovens, controlling traffic signs, to being a CPU in a personal computer. By adding memory to a microprocessor, you have a microcomputer. Hundreds can be made from a large silicon crystal. But, only some of them will work. That, plus very expensive design costs meant that the first microprocessors cost hundreds of dollars. Now the new microprocessors are cheap and getting still cheaper.

As time permits, I would like to give you a sample of actual use statistics in rural settings with which I am familiar. This is part of a report that was submitted by Paul Rowland, a computer literacy instructor and consultant from New Mexico State University. "During the 1982-83 school year the Cloudcroft, New Mexico school district received an introduction to computer uses in education through a visit from the Computer Experience van from NMSU. (This program is described in another presentation of the REA Conference.) The experience proveded the district personnel an opportunity to react to educational computer use, and they reacted most positively.

A call for bids was sent out for 16 microcomputers with network for the elemen tary school and 14 networked computers for the high school. At the time two TRS-80 Model III computers were in use in the elementary school and 4 were being used in the high school in a programming class.

The reason the call for bids required networking capability was that the school felt that it could avoid buying cuplicate software for several machines as well as avoid buying a storage device (diskette) for each machine.

It is likely that the bid specifications were influenced by the fact that the school owned TRS-80's.

Qualifying bids were received from Radio Shack, Apple, and Commodore dealers. The Apple bid was very high; the Radio Shack bid was slightly lower than that from the Commodore dealer. The Radio Shack bid for 64K Color Computers and a Network II for the elementary school and 64K Model IV's with a Network III for the high school was accepted.

Radio Shack not only promptly installed the computers in elementary school, but also sent their educational consultant from Denver to spend one and one-half days working with the teachers in LOGO, BASIC and educational software. The same will be done when the high school network is installed.

The key factors contributing to the success of Radio Shack in this market have been: nearness of dealership, promptness of bid, support for hardware, and professional educator support. In addition the ability to demonstrate and provide a network and a large selection of software (catalogued in their own book) has reinforced the district's feeling that it made a good decision."

A summary of microcomputer availability and use at New Mexico State University was conducted during the spring of 1982. Here is a summary of the survey. The size of our student body is 12, 400. Total numbers for each college is given here. Agriculture and Home Economics = 18; Arts and Sciences = 89; Business Administration and Economics = 4; Education = 11; Engineering = 99; Other institutes = 7; Other Administrative Offices = 9; Dona Ana Branch = 5; for a total of 242. Here are the results of the survey by brand name of stand-alone computers: Apple = 27; IBM = 3; Northstar = 16; Osborne = 6; Terak = 83;

Tektronix = 7; TRS-80 = 8 and other = 24.

Some of the best statistics country-wide may be obtained from the Microcomputer Directory: Applications in Educational Settings, Second Edition, 1982 compiled by the staff of the Monroe C. Gutman Library at Harvard University Graduate School of Education. Cost is $15.00.

Usage:

One of the primary sources for information about the use of microcomputers in education is the Northwest Regional Educational Laboratory located in Portland, Oregon. I will relate to you some of the highlights of their document, "Microcomputers in Today's Schools: An Administrator's Handbook." Northwest kept track of a large system of stand-alone micros over a four year period and found that the cost was less than $1.00 per student hour including courseware. It was noted that when you bring the computer to the students, there is no communications costs other than electricity. No special operators are required. No modification of facilities is required, except, perhaps, an alarm system to help prevent theft. But does the use of micros promote learning? Two areas where no significant gains have been shown are typing and accounting; however, a combination of CAI and traditional instruction does show gains in both the elementary and secondary levels. On the other hand, the results are not conclusive when CAI is used as a replacement for traditional instruction. Northwest recommends that the use of computer-assisted instruction be actively promoted and expanded.

This would be especially important for small schools in rural areas where it is difficult to offer full schedules of classes to limited numbers of students. It is also recommended that CAI be used with low-achievers and alienated students. An interesting report on this is "The effectiveness of CAI: A Survey of the Research," by R. Wilson from Northwest. Research is just beginning in many of these areas. The Computing Teacher Journal recommends that research look at: effectiveness of CAI on -- achievement, motivation, attitude, retention, time-on-task, interaction, etc. Several of the major researchers in this field are summarized below:

Mravetz reported in 1980 that rural, caucasion junior high students who were reading at least one year below actual grade scored significantly higher on reading achievement after CAI than did comparable students having the same teacher.

McEwen and Robinson (1976) reported that beginning French students who received CAI spent about 30 fewer hours in classroom instruction, but achieved at the same level as comparable students receiving traditional instruction in the same subject.

Edwards (1975) found that two of three reported studies indicated that CAI students retained material less well than the non-CAI students. This is one of the few negative findings I ran across.

Thomas (1979) says that retention of learned materials was about the same for CAI and non-CAI students.

Litman(1977) in a study of remedial readers showed that males

receiving CAI maintained their advantage over non-CAI males when retested after two years. The weight of evidence is overwhelmingly in favor of CAI.

Another way for schools to look at micro instruction is to consider the cost-benefit or cost-utility or cost-feasibility of such an investment. The HEW has a helpful publication for you to use when conducting such an analysis for your district. It is called, "The Resource Approach to the Analysis of Educational Project Cost." It is available from the U.S. Printing Office and I can give you the document number. In it, the HEW cautions you to consider the costs carefully -- the beginning costs are not the only ones. You should consider the following costs when installing a computer instruction program in a district:

A. Acquisition costs, these include
    1. Hardware
    2. Software
    3. Curriculum Development and/or Selection
    4. Teacher Training
    5. Evaluation Design
    6. Facilities
        A. Purchase, lease, or rent space
        B. Remodeling of existing space
        C. Installation of Equipment
        D. Installation of Security Devices

B. Operational Costs
    1. Maintenance and replacement of hardware
    2. Updating and replacement of software

3. Updating or revision of curriculum
4. Periodic in-service sessions
5. Evaluation Services
6. Utility Charges
   A. Phones
   B. Power
   C. Computer Time Charges
7. Transportation costs
8. Salaries
   A. Teachers, aides, specialists, others
9. Management support services
10. Materials and supplies
11. Contracted services
12. Media services

Naturally, the more students who can be scheduled onto the micros, the lower the cost per student hour.

Here are some examples of costs:

1 station = $1.20 per student hour (1000/yr.)

16 stations = .36 " " "

96 stations = 1.47 " " "

The availability, quality and effectiveness of courseware are also essential considerations.

Literacy:

Several authors in the Northwest research agreed that computer literacy will be left to industry if educators do not assume some responsibility for developing courseware and preservice or

inservice education for teachers.

Stuart Milner feels that these coursework areas are essential for teachers:

1. An introduction to instructional design
2. Design of computer based materials
3. Programming - at least 2 courses
4. Hardware and software organization
5. Uses of computers in society
6. Uses of computers in education

J. Richard Dennis lists these skills necessary for computer -using teachers:

1. Familiarity with software in a variety of fields
2. Ability to integrate software into a course
3. Knowledge about CMI
4. How to identify effectively designed drill and practice materials
5. Familiarity with simulation
6. How to evaluate a course that uses CAI
7. How to determine the computer needs of a school
8. Familiarity with instructional games
9. Familiarity with hardware
10. Trouble shooting procedures
11. Sources of computer materials
12. How to improve inadequate materials
13. How to teach computer literacy skills
14. Some knowledge of programming

(look up the document and finish this list of 25)

Trends: (as viewed by Northwest)

1. Hardware manufacturing is very fluid - new companies are appearing with no track record for production, delivery and support. Take Osborne for an example.
2. Use of software as tools for applications development rather than courseware
3. A lot of maintenance is on a carry-in or mail in basis
4. You will be dealing with small, independent stores. Some will be good, some not so good.
5. Major publishers are beginning to develop software
6. Lack of compatibility will continue to be a problem.

A district will benefit from contacts with other large districts whose experience in specific applications is more extensive. Here are some recommendations for districts:

1. A district should develop goals and objectives for computer use.
2. the computers should support basic skills instruction. The reason for this is that more money should become available for applications of computers in the basic skills areas.
3. The diagnostic and prescriptive needs special education should receive attention
4. Districts should develop a sequence of implementation and have periodic reviews of progress and attainment of goals
5. Districts should consider specifying a single multi-purpose computer for district-wide use.

6. There should be a comparative analysis of software
7. Districts should seek opportunities to become a field testing site for new programs.
8. A computer education coordinator should be appointed
9. You should be providing staff time for learning and in-service opportunities

Go out and find some teachers using computers in a setting similar to yours. Try to view several different brands of computers in use.

Here are some important comparative considerations regarding different brands of computers:

1. Cost
2. Ease of implementation
3. Ease of Operation
4. Flexibility
5. Multi-purpose use
6. Software cost
7. User control
8. Available software
9. Difficulty of application development
10. External reporting
11. Integrated applications
12. Limited usability
13. Operational responsibility
14. Reliability

Future:

The future, in a sense, is here already in the form of the videodisc machine. Those of you who have seen it can sense the power that it has, in revised edition, for education. A signel videodisc stores 54,000 separate full-color frames or 30 minutes of instruction. The frames are numbered and are randomly accessible. The frames can be replayed, forward or backward, at regular, fast, or slow speed. An intelligent videodisc is connected to a computer. Such a system capitalizes on the random accessibility of videodisc frames, allowing the instructional designer to program the display of a particular single image or a motion picture segment in any desired combination, contingent on student response. The videodisc has the capacity to store large quantities of digital data -- about 10 billion bits, or 5 times the information contained in the Encyclopedia Britannica. Combined with a video responder, the system permits interactive learning, branching and external reporting of student progress.

According to Northwest, the characteristics of an ideal instructional delivery system are:

1. Careful instructional design
2. Diagnostic and error analysis capabilities
3. Automatic record keeping
4. Adaptability to a child's learning style and rate
5. Full array of visual & auditory stimuli
6. Ability to maintain high level of student involvement
7. Fully interactive
8. Reinforcing on a selective schedule

The great strength of the computer, of course, is that it is inter-

active.

Northwest concludes by recommending that htere be communication among individual users of technology. There needs to be a system for assessing grassroots courseware. And there must be systematic cooperation in purchase of commercially produced software. We must all report our efforts to assess hardware.

Gerald T. Gleason reports to us by way of an article in Educational Technology magazine called,"Microcomputers in Education: The State of the Art." Gleason is from the Minnesota Educational Computing Consortium (MECC). He reports that the National Science Foundation estimates that by 1985, one million micros will be in use in the schools. Chambers and Bork indicated that during the period 1980-85, use of computer-assisted learning will increase from 54 per cent to 74 per cent.

The current leaders appear to be Apple and Radio Shack. The Commodore, one of the first, has fallen behind in the frantic race for consumer acceptability. Improvements are becoming available, such as touch-sensitive screens, light pens, bubble memory systems, videodisc interfaces, random access audio devices, etc. Nearly all universities and many large public school systems have well-developed systems which harness the power of large computers to provide interactive computing for students and faculty. However, many universities, including my own, have decided that providing stand-alone micros to students is also one of their responsibilities.

There are large-scale time-sharing systems like Plato. A Plato terminal costs about $6000. With Plato, one has access to a large and growing library of software. The access to a large selection of software will continue to justify the existence of the time-sharing systems. Plato can do some things better, such as answer judging, and student record keeping, etc. However, micros are the wave of the future. Hardware improvement will be continuous. Many have said, "It's not the machine that's important, it's the program that's in it." But now both are important and each must be compatible with the other. Much of the promotional literature for micros leads the prospective purchaser to believe that all you have to do is learn a few simple commands in basic and you will be able to write your own programs and develop your own lessons. This is not the case. One has only to examine some of the programs offered for sale to realize that there is far more to CAI programming than learning to operate a micro. Some investments in time and money are required. The cost of high quality programming is estimated to be $10,000 per instructional hour. Companies are finding that they have to provide extensive training to their CAI production staff. The market is unstable for software and there is the problem of transportability. But some of these problems are being surmounted. Some well established publishers are offering entire courses accompanied by correlated and integrated micro programs. At this time, the profit incentive for high education software is really minimal. One of the leaders in the development of CAI for higher education is Professor Stanley Smith of the

Department of Chemistry at the University of Illinois. There are quite a few groups engaged in the review of software. Among them is the Conduit group funded by the National Science Foundation. Their monthly publication PIPELINE reviews CAI in higher education. Northwest Lab in Portland established the Micro-Sift Clearinghouse for reviewing CAI in grades Kindergarten through 12. Educational Technology has begun to review also. Unfortunately for educators, the production and dissemination of CAI software is at a very awkward stage. As with software, there is presently a huge shaking out process going on in which many small, quality producers may fall by the wayside.

Computer Literacy:

Gleason maintains that there is no consensus on the precise knowledge, skills or attitudes that an individual needs to function adequately in a technological society. It is generally agreed that schools must have teachers who themselves are knowledgeable about computer applications. In the beginning, only teachers who were interested used the micros. Somehow, probably through advertising, we have come to the conclusion that knowledge of micros is essential to our professional survival. The ripple effect of advertising and inservice programs rapidly expanded the number of eager users. The few who stand resolutely on the sidelines are considered archaic. After using a Ph.D. in Computer Science to teach an inservice workshop, many school districts have found that after giving formal training to a small group of teachers, then they can

be used as consultants for the rest of the faculty.

On the whole, Though, Gleason has found that preservice CAI experience is woefully lacking. During the next few years, a great effort will be taken to provide literacy for the general public and for teachers.

Research:

The current state of findings, according to Gleason, are

1. CAI can be used successfully to assist learners in attaining specified instructional objectives
2. There appears to be a substantial savings in time (20 to 40 per cent) required for learning as compared to conventional instruction.
3. Retention following CAI is at least as good if not superior to retention following conventional instruction.
4. Students react very positively to good CAI programs and they reject poor programs.

Current research tends to focus on the following problems:

1. What are the most effective CAI strategies? What type of feedback is most effective? How often? At what point in the program? What types of learner interaction are most productive? Which instructional paradigms are most effective in the various content areas?
2. What are the interactions of individual learning styles in CAI? How much cognitive complexity can the learner manage? What concept-learning strategies are most appropriate for which types of learners?

3. What are the effects of individual learner characteristics such as memory span, perceptual skills, sensory preferences, intelligence, etc.?
4. Which hardware configurations are most effective and efficient in various types of programs? Audio? Touch-sensitive screens? Video disc? Light pens?
5. What affective characteristics of the learner are important? Motivations? Persistance? Delayed gratification? Locus of control?
6. What are the most effective strategies for program development?
7. What are the most effective strategies for integrating CAI with other instructional activities?

Gleason raises these further questions:

1. What will be the impact on social interaction in the classrooms?
2. What effects on individual motivation, self-direction, and self-sufficiency will we see when so much control over our daily lives is relegated to computers?
3. What steps should be taken to assure us that the omnipresent computer will not diminish our personal sense of individuality, and respect and commitment to humane values?

<u>The Future</u>:

Gleason admits that we really do not know how far and fast technology will take us. He seems pretty certain about the following state-

ments:

1. There will be dramatic and exciting developments in communications hardware of all types. Voice recognition and speech generation will become common. Memory size of computers will become irrelevant. Interfacing with other computers and other media will be common. Technological development will be far ahead of actual application. Schools will continue to lag far behind other institutions.
2. Instructional applications of computers will take place at an accelerated rate. Business and industry will begin to insist that schools develop not only computer literacy but also the competency to work with and use computers.
3. Technology will have a far reaching impact on schooling. In the future it may not be necessary for a child to go to school.
4. The burden of teaching content will be substantially diminished. But what is left for the teacher to do? Perhaps more time can be spent teaching social interaction, value development, civic responsibility, creative thinking and cultural appreciation. Schools and teachers and other people will continue to be essential. They will be needed for the role of planning and providing those higher order learning experiences that cannot be provided by technological devices.

5. The entire concept of learning, then, will undergo a gradual but significant change. It will no longer be necessary to go to a school to learn many of the skills that are required for effective functioning in our society. Leisure time will be dramatically expanded and individuals will have time and ready access to the resources needed to learn - how to read, how to cook, how to design, how to create, etc. Learning will be living, not just what you do in school.

In a paper done by Bruce Kelsh and John Lindelow for the Oregon School Study Council called, "Microcomputers in Schools: Promise and Practice," it was found that micro usage in the Oregon schools increased by 800 per cent between 1979 and 1981. In this same paper, several notable speakers have given their opinions about the state of the art. W. James Popham from UCLA says, "Since the early 1960's educators have been listening patiently to the transistorized tales of future educational rapture spun out by computer buffs."

Arthur B. Shostak envisioned that education will undergo the kind of radical "root and branch" revision brought about by computers. When micros were introduced, says Frenzel, "The same rhetoric about CAI being the ultimate teaching technique," was heard again. Joseph Scandura comments that writing good software is a much more difficult, expensive,and time-consuming task than writing a successful text. It takes a special combination of knowledge and skills that is still difficult to find in any one person.

Popham noted that federal funding for the development of software ended when the projects "failed to secure quick and widespread educational improvement.."

Private industry tried but could not turn a profit. In the 1960's some large publishing companies lost their shirts trying to market courseware. And yet, as the cost of the hardware drops, there will be a huge potential for sales in this area. As you have heard, the world of artificial intelligence is coming fast. In 1979, a computer beat the world backgammon champion. In chess, computers are now able to outperform the experts who program them. So computers will be able to take over some teaching functions, particularly the teaching of rulebased subject matter. The classroom teacher will still be needed to manage student' interaction with the computers, provide traditional teaching in the "higher cognitive" and more complex subjects, and provide individualized instruction to students who need. it.

Parents will supplement their child's education with home computers. Some software will be available with a variety of value systems for parents to choose.

The Oakridge school district in Lane County, Oregon, quickly found that time sharing was costly, unwieldy, and was interrupted by a lot of down time. In that district, exposure begins in the seventh grade. As students skills increase, so does the complexity of the assignments. Oakridge plans to move down in to the elementary grades with micros. Snuggerud explains that programming causes you to work with concepts and the processes that are involved in problem-solving." In Snuggerud's estimation, the really zealous computer enthusiasts tend to be male, quiet, often shy, and not very active socially or athletically. Oakridge speaks well of the Apple computer. They estimate that half of the software that is acquired will not be usable for a variety of reasons. They maintain that Apple documentation is good.

Carver predicts, "We're going to see a lot of packaged instruction that will refine training and talent, but the teaching of concepts , and the interaction that has to be there, will be there only with a teacher."

Holznagel says about software: "The kind of material that is available and is likely to become available in the near future is not completely tutorial in nature. It will not be able to replace all teacher functions. It's all supplemental. The bulk of material available at elementary level in basic skills replaces only certain teacher functions like drill and practice activities.

Sanner holds the same opinion: "I think that the micro is not going to replace teachers-- not good teachers, that can't be done. It will allow teachers to do a far better job of using the capabilities they have in managing students. By the year 2000 I don't think we're going to find classrooms all around the state filled with thirty micros. I can foresee perhaps five to a classroom. The ability of the software to meet the needs of a variety of students will be the critical factor. Having teachers create their own software will not be the answer.

Jones sees three possible scenarios: 1. micros would usher in the golden age of education. Teachers would be relieved of tedium and would be able to respond to students one-on-one. 2. Micros would increase alienations and dehumanization of mankind. 3. Schools will go on as usual. There really will not be any major change.

Classroom Uses of Microcomputers: Most of you here know the multitude of uses that micros can serve in the classroom. We are rapidly approaching the time when computer awareness will no longer be a justification, if it ever was, for

having a computer. The awareness part, including the history, applications, careers, attitudes, etc. is now being included in what is termed computer literacy. The computer literacy areas seems to be where most schools are presently investing most of their efforts. The literacy varies according to the grade level, but is surprisingly similar through a large range of grade levels. A lot of teachers are opting for immediate hands-on instruction as a way of initiating motivation early in the course. Knowing the history of computers doesn't seem as important as it once did. The students learn the controls on the key board, how to boot up an existing program, how to initialize a diskette, and how to write a simple basic program. The next phase of the course can include an exploration of commercially produced software and the beginnings of elementary program writing. As Tucker points out in his article on the Classroom Uses of Microcomputers, it's probably a good idea to introduce word processing skills early in the learning since it generalizes to so many other disciplines. One of the strongest assets of micros is their ability to interact with the user. Naturally, it only says what is has been programmed to say. The more sophisticated the interaction, the longer and more complicated the program. The best programs are user friendly. By that we mean the program uses the student's name and handles mistakes in a gentle and supportive manner. Another aspect of a friendly program is clear instructions. And one needs to know how to correct errors. The user needs to feel that the program/computer is cooperating to help solve problems. User friendly programs are also more tolerant of variations in correct answers. If the correct answer is 2, then the program needs to give credit when the user types in "two." Users learn very quickly to be careful about spelling and other essential characters when communicating with the computer. They need to know certain trouble-shooting procedures, such

as check your spelling, check the manual, ask for help, etc. It is only interactive to the degree that certain rules are followed. For really divergent and creative thinkers, the programs can sometimes be frustrating and even misleading. Aside from the relatively minor drawbacks, the interactive nature of computers remains their most distinctive and useful characteristics, aside from speed and memory considerations. Another powerful quality is the ability to provide individual attention to the user. Notice, I did not say individualized instruction. Thus far, I have not seen what could truly be called individualized instruction, unless one relates to one part of a comprehensive math program. But progress is being made in this direction, and the motivational spinoff here is usually remarkable with most users.

Computers are attractive to users because they are non-judgmental. A computer can tell you you're wrong without making you feel guilty. Thus, students are more willing to experiment and to make risks on a computer. In addition, computers are very patient. They will wait as long as it takes for the user to figure out the answer. Repitition does not frustrate the micro as it might a human. This quality makes self-paced learning a reality. It also makes for some interesting challenges in scheduling micros for use by everyone in a classroom. What blocks of time does one allot to each user so that each person can achieve maximum benefit? This question has yet to be answered.

The computer functions well as a laboratory aid. It can simulate experiements that would be too remote or expensive or dangerous to actually perform in the school. The physical sciences are creating some exciting programs in this area.

The computer has no equal as a calculator. It fits in naturally in the math classroom, but there are many areas of life where help with a math problem makes us ass a lot more productive.

This leads me to mention the micro as a problem solving tool. This may eventually be the greatest advantage of computers. Right now, there are few of us who could efficiently instruct our students in the uses of micros to solve problems. We, as teachers, must first learn how to do these things ourselves before trying to teach the skills to our students.

Educational management has known about the value of computers for some time and that is where the money originally went for micros. It can keep attendance records, budgets, class schedules, record grades and an abundance of other time-saving chores. The trick for teachers is to find time on the computer to do these sorts of tasks. I guess that's what the middle of the night is for. The computer should assist schools as tutor and presentation aid. Such Things as color, animation, graphics, and sound add to the attractiveness and motivational power of the micros. We know that graphi cs programming is not now easy to do and takes a lot of memory, but emerging hardware and software development promise to smooth the way to a variety of presentation possibilities. Micros are becoming more adaptive to the arts. A new program has been written that presents the artist with a huge number of colors and color combinations with which to paint. Schematic drawing has been possible for some time using the light pen and programs that convert your hen scratches into polished drawings. The micro as musical instrument cannot be overlooked. Composition and music Theory are taught as well as drill in music fundamentals. Finally, the micro can be a challenging game partner. To the extent that it teaches as the game is played, micros improve the user's decision-making skills and expand the imagination while possibly expanding attention span. Games as teaching tools have not been exploited to their full potential. And yet, children don't necessarily expect games all of the time while using micros in the schools.

Marc Tucker, former Associate Director of the National Institute of Education has this to say: "Most of the schools are backing into the computer age with their eyes on the past instead of the future. They either use computers as drill machines or they try to train junior programmers with the mistaken notion that the economy will be pining for their skills. Unless there is a quick reversal of this misuse of technology, a precious opportunity will be lost to make the schools relevant to the children's and the nation's future needs." The use of micros, he found, generally goes for activities where the money is available, that is, drill and practice in the basic skills. He maintains that, after a while, drill on the computer becomes just as boring as drill without a computer. Tucker is an advocate of using older students to drill the younger ones. He describes usage that resembles past audio visual machines, such as the teaching machines. Tucker advocates that computers must be used to make students flexible, creative, able to understand what they are doing and capable of asking why. However, he is not highly specific about the exact methods to achieve this end. He is also critical of teaching pupils to program as a vocational goal. The need for programmers by the multitudes, he believes, will not be that great. His basic premise is that the computer should be used as a tool. An example of this would be to teach word processing so that students will have unlimited opportunity to write, rewrite and edit. This activity is one that is difficult to provide for in the ordinary precomputer classroom. Thus, its value in education. Tucker's final point is that the micro can be used across the disciplines and he gives several interesting examples of applications in the social and physical sciences.

Alan L. Roecks writes about "How many Ways Can The Computer be Used in Education? A Baker's Dozen." Here, briefly, are his suggestions:

1. Administrative

   accounting, payroll, and employee records, attendance, grades

   student records, timetables, planning systems

2. Curricular planning

   Resource information file, and production of instructional materials

3. Professional development
4. Library
5. Educational Research
6. Guidance and special services

   vocational counseling, diagnosis and remediation

7. Testing

   Test construction, test scoring, test evaluation and analyses

8. Instructional aid
9. Instructional Management
10. Computer-Assisted Learning
11. Computer Awareness and literacy
12. Computer science
13. Institutional coordination, information sharing, and coordination of existing computer services

Advantages and Disadvantages of computers and software:

Advantages: Increased student motivation, multisensory media, immediate reinforcement, record storage, individualized instruction, efficient record keeping, progress monitoring.

Fred Deluca writes about these disadvantages: 1. initial high cost, 2. writing programs takes time, 3. repairing hardware requires expert help, 4. programmed tasks are less flexible, 5. the hardware is not specifically designed for education, 6. high quality software is lacking, and 7. creativity may be stifled.???

Computer Literacy: "Teaching Computer Literacy in Elementary Schools," by Nordman and Parker is the source of the following information. Nordman and Parker were teaching literacy in grades five through seven using the basic language. The results showed that the pupils could 1. input programs quickly, 2. proofread and edit their input, 3.. modify existing programs, 4. analyze simple problems, and 5. maintain high interest through the course. They found that there is a need for whole group interactive discussion to build comprehension. It was helpful to use a large monitor to introduce certain practices to the whole class. A student worksheet was utilized. It was handed out for them to type and run. The next step was to have them change the program and see what happens. Then they were assigned a programming problem. The students had to document their programs by keeping anecdotal records of successful and unsuccessful attempts. Gradually, the students developed accuracy and speed in typing. They came to analyze programs quickly, accurately and confidently. The use of early worksheets was successful. However, 60% failed when required to learn print, input, if then, and for next programming commands. These concepts are harder to master. Continuity is very important to learning these skills. The attitudes remained positive, but the gains in proofreading skills are subject-specific and without general transfer.

Seymour Pappert, who has done a lot of work with young children on computers and helped developed the LOGO language, holds the position that working with

a computer can make it easier to understand styles of thinking. It is an antidote to purely mechanical thinking. It also gives the user some insight into his/her problem-solving strategies. Since the computer demands precise and logical attacks, the student gets some intuitive

Pappert lists some of the variables involved in teaching computer literacy: They are difficulty of the material, course structures, hardware limits, room layout, teaching environment, group dynamics, teaching methods, etc. The BASIC language is difficult to use. It requires a lot of teacher assistance. Some easier languages to use are: Pascal-Pilot, Logo, and smalltalk. Piaget has said that the level of abstraction in the BASIC language could help defeat its instructional value, especially with young children. Of course, one can always ask the question, "Why teach programming?" But let's assume for the moment that some familiarity with introductory principles of programming may be helpful to users of any age. One cannot compare the similarity of teaching programming to any other subject. Some of the problems are: the methods used for sign-up on terminals; time allowed on micros per individual; how to efficiently run in-service workshops. When students are allowed to sign up for free spaces, there is some difficulty with erasing of names. Having a teacher-controlled sign up book is better. During in-service workshops, it is best to assume that the teachers have little or no back-ground with micros. The teachers generally want to be treated like students. It may be wise to pre-sample you audience of teachers to see how much experience they already have with micros. Teacher perceptions are very important. It may be smart to begin by telling teachers that they are not going to be replaced by the computer, and that if they learn to use it well, it may make their job of teaching much easier.

Pappert sees merit in beginning the workshop with an introduction to flow-charting.

Very briefly, let us consider the criteria for selecting a hardware system: cost; reliability, expansion potential, software availability, ease of operation, availability of support and maintenance.

Software Evaluation:

Bob Jackson has written an article about quality software and in it he says, "There's a lot of junk out there." This is something that most of us have known for some time. According to Jackson, quality software should be: 1. Free of technical or pedagogical errors; 2. should take advantage of the machine's unique capabilities without substituting flash for substance; 3. should provide positive reinforcement and help students to understand wrong answers; 4. should include some diagnostic and branching features; 5. Be creative, stimulating creativity among its users; 6. allow for easy teacher modification; 7. provide clearly written support materials. To that, I would add another -- instructional programs should provide an easy way to keep student performance records. Only eight requirements of a good program? If anyone does all eight, it would be a perfect program! I have yet to see a perfect program. But some recent ones are really improving in quality over earlier versions. Programmers must be learning from their mistakes. You know that the ease of copying programs is what has really hindered the progress of software development. It takes all of the profit incentive away from the developer. It has slowed down publishers from investing large sums in broad programs. Keeping in mind that it costs anywhere from $10,000 to $12,000 to develop a decent program, one can understand the reluctance to just give it away. One the other hand, there is some quality software

available in the public domain. One should make a maximum effort to discover and exploit all of the public domain programs whereever they may be housed. William Gattis, Director of Radio Shack's Education Division points out that "quality software produces achievement or learning gains, determined through field testing." Another good way to track down quality software is to talk to people who have used the programs in the schools.

In another study done by Vicki Cohen, a software evaluation instrument was developed with 96% reliability that was used to evaluate a drill and practice program in Math. The program did not stress higher order skills. Few of the programs used in the study taught very many new concepts. Graphics are rare; there was little user control over the speed or direction of the materials presented; little in the way of remediation was offered; and hardly any of the software engaged the learner in what could be considered genuine problem-solving. All of the software were evaluated according to the following criteria: 1. Curriculum role; 2. mode of interaction; 3. student sequence; 4. format; 5. graphics; 6. cues and prompts; 7. action; 8. whether or not it offered the option for computer managed instruction; 9. user control; 10. feedback; 11. record-keeping; 12. random generation; 13. packaging; 14. teacher management and student management; 15. response time and loading time. The types of interaction were judged according to the following categories: 1. drill and practice; 2. tutorial; 3. games; 4. simulations; 5. problem-solving; 6. exploration. Cohen declares that the feedback built into programs must be 1. non-threatening; 2. immediate; 3. not over-reinforcing; 4. remediate when necessary; 5. not reinforce wrong answers ; 6. relevant to age and level.

Software needs, as seen by Cohen, are 1. higher order learning; 2. more that are useful in junior high and high school; 3. provide more ways to interact with the computer; 4. address writing skills; 5. give better management systems; 6. insert more graphics; 7. create more motivational devices, and 8. come with better packaging (instructions, documentation; field testing results,).

Cindy Tursman helps us to summarize Seymour Papperts important contributions in an article called "Powerful Ideas." She begins with a quote from Pappert: "In my vision, the child programs the computer and, in doing so, both acquires a sense of mastery over a piece of the most modern and powerful technology and establishes an intimate contact with some of the deepest ideas from science, mathematics, and the art of intellectual model building."

Since programming means solving problems or debugging, learners have to think about thinking and break down problems into discrete steps. In Papert's words, "When children teach the computer what to do, they must think through what they want it to do and thereby develop a deeper understanding of the material. Like Piaget, Papert feels that children learn a great deal without being taught by drawing on elements and experiences in their environment. Papert's work at a Logo Nursery school in Dallas demonstrates how children can use their knowledge of the noncomputer culture, adapt it to a computer setting, and learn something new, such as formal geometry, computer programming, or grammar. Papert has found that children as young as three can learn to program the computer and master the keyboard by imitating one another and drawing on body movement cues. It also allows for trial and error in a nonpunitive atmosphere. Seymour says, "Most people don't have an opportunity to precisely plan a

project, split the task into its components, reach a first solution, find out what's wrong with it, and then take another shot at it." With a computer you can undertake very complex projects where nothing is at stake. Restrictive uses of computers for pre-packaged drill and practice exercises can actually prevent certain students from learning. Papert's approach enables learners to explore and personalize powerful ideas like belocity, force and acceleration by creating models and microworlds based on geometry, differential calculus, and Newtonian physics. These models are easy to think with and bridge gaps in formal mathematics training. Papert thinks every young child should have a computer. He warns that "there are political issues, such as where America stands in terms of its competitive power in relation to other countries. Japan is pushing further in really seeing learning on a social level and helping both children and adults learn new skills and how to adapt to new jobs as technological change makes old outlooks obselete." Like Piaget, Papert believes that learning is largely a matter of manipulating, controlling, and applying cultural and environmental elements to new situations and problems. They can be used to solve complex problems and accomplish tremendous learning gains. Whether or not a society decides to do this, however, may depend on the value society places on education and technology in solving industrial, societal and social problems. Finally, Papert thinks that it is cost effective to give every child a computer in school.

Future: Robert Hamrin writes in the Futurist magazine about "The Information Rich Economy: Exploiting an Infinite Resource" He tells us that since the mid-1970's, America's work force has been predominantly engaged in information handling. The Industrial Revolution enabled people to expand their physical

capabilities. Now, the computer revolution is expanding the power of the brain. The Industrial Revolution was based on the finite resources such as coal, oil and iron. But the computer revolution is based on a limitless resource-- the supply of knowledge and ideas. Computer circuitry that in 1955 cost one million dollars can be bought today for about ONE 1955 dollar. By the turn of the century, we will be using devices 1000 times more powerful for only one 1955 penny. The chip that is now the size of a postage stamp will soon be the size of a grain of sand. Soon the computer will respond to voice commands. It will be able to read like, and much faster than, a human being. The auto industry plans to make their plants 90% computer controlled by the end of the decade. The launching of only one satellite will have the transmission capacity to provide every person in the U.S. with a computer terminal during peak usage hours. By 1985, worldwide revenues to the information equipment industry will probably reach $145 billion. Certainly, telecommunications will help conserve energy by cutting down the necessity for and the cost of business travel. A substitution of information-intensive capital for energy-intensive capital will enable us to make future productivity gains. Hamrin sees some of these uses in education: Micros force people to do things correctly so that it imposes a sort discipline. Computer literacy will certainly become a criteria for school promotion. That goes for faculty, too. Adult education will change drastically. Much of it will be done in the home. The cost of education will be brought down and equal opportunity and access will become a reality. One of the dangers is that this new information utility may encourage the centralization of authority-- a sort of big brother syndrome. Urbanization could become redundant. Unfortunately, it could also bring about a reduction in

the amount of interpersonal communications. The need for everyday encounters will be reduced. Nathan Cook of MIT says that computers and robotics could reduce the costs of small-lot manufacturing by 80 to 90%. Production could improve by as much as 100%. Of course, the demand for human labor will be reduced. A lot of job shuffling will occur. But many new jobs will be created. There will be a huge increase in the number and diversity of leisure activities. More time will be available.

More about the future from Alan Hald who wrote "Toward the Information Rich Society," again in the Futurist magazine. He predicts that soon 10 large computers may be compressed to the size of a wrist watch. He thinks it is feasible within this decade to build an affordable house computer that can monitor its physical condition, maintain itself, and communicate with its inhabitants or even with other houses. A small library could be quickly accessed through this equipment. The information would be automatically adjusted to your level of understanding, whether you are a five-year-old of a doctor of zoology. A child would quickly become experienced in searching for and finding information on anything--relating ideas and weaving patterns of understanding, developing a form of thinking that would be highly conceptual. These new self-selective media may also provide everyday information such as supermarket prices, event schedules, daily newspapers, etc. A far greater challenge than preserving privacy may be developing the capacity to deal with the instant availability of tremendous amounts of information in a meaningful way. Our ability to create new information technology that will allow People to easily organize information into pliable and meaningful patterns may become essential to our survival.

Discussion of the future must include some mention of super computers, because they are the wave of the future. As you know, the U.S. and Japan are in a heated battle to see who can develop the next generation of super-computer -- a machine that thinks. Both nations are gearing up to build the 5th generation computer that will be knowledgeable, solve problems and carry on a dialogue with its operator. Actually, supercomputer speed is already here and is being used in aircraft design, oil and mineral exploration, and weather forcasting. Soon, shipbuilders and the automobile industry will take advantage of super speed computers. Michael Dertouzos, the Director of the Computer Lab at MIT, warns "The Japanese recognize that whoever controls the information revolution has,in effect, some form of increased geopolitical control." At this time, there are 74 super speed computers in operation, all American made. The Japanese, of course, are hoping to gain the upper hand in this area and are already advertising the availability of a new 256 K chip, which will, once again, revolutionize the micro field. This is an exciting time because we are experiencing the making of history that will determine who will be the first-rate power and who will be the second-rate powers in the world. To quote Newsweek, "The losers in the race will fall farther and farther behind." We are anticipating computers in the near future that can think and reason somewhat like people and that can "understand information being conveyed by sight, speech and motion." This progress is being moded by the military-industrial complex. Most of the money that keeps the U.S. abreast in the field of computers comes from the military, but advancements spill over into the private sector. Education is benefitting by this spillover in technologies, but what filters down is not being planned or coordinated in a very comprehensive or intelligent manner.

Education has had the reputation in the past of being about 50 years behind the rest of the society in terms of the technologies available to use in the classroom. This may be changing. Industry may be realizing that if they leave the schools too far behind, their training role will be too overwhelming. Gradually, we are seeing more industries face the fact that they must invest in quality education as a way of insuring future expertise. But how do we guarantee turure expertise when the present nature of technology is changing so fast? Good question!! Where does the direction come from for the nature and content of instruction? The video games which have captured the interest of this nation's young people were a direct spinoff from the technology that was developed to simulate conditions in military confrontations. Will our curricula always be a reactionary to what happened in a war room 25 years ago?? It may always be that way. It is possible that only the military/industrial complex is in a position to know how the schools should be used to support the progress/survival of civilization. Certainly, the quality of our lives has been enhanced by this same complex. The Apple IIe in my office can execute 500,000 operations per second. Japan's super speed goal is 10 billion operations per second. We are nearing the next plateau: articifial intelligence. The question is: What do we do today in our classrooms to best prepare students for what they may encounter tomorrow?

How is the microcomputer impacting on rural schools? According to Paul Rowland of New Mexico State University, the rural schools of our area are fuzzily divided into two groups: 1. Those rural districts that are watching and waiting to see where the technology is going and what other districts are doing about it; and 2. the districts who are going "whole hog" into the

instructional computer business-- buying lots of machines and software and providing considerable hands-on time for their teachers. In these small districts, the number of computers per capita for teachers and pupils is pleasingly high. In order to get your hands on a computer, it may be to your advantage to be in a rural district. These rural districts may also be in the best position to conduct meaningful research to find out about students using micros. In the long term, schools with micros will close the gap with opportunities for teachers and students to gain experience. Gradually, this gap will widen between those districts which have provided the opportunity and those which have not. Where will the funds come from? In New Mexico, we have been fortunate to have a legislature that recognizes the importance of giving equal funding to small districts to help equalize the educational possibilities. Some other states are not so lucky.

The critical element seems to be how the faculty is trained. The districts that we have observed whose faculty was forced into micro training have had poor reactions. In other cases, the superintendent and principals have simply led their teachers in slowly, giving them a year or so to get their feet wet.. In the former case, the teachers were reluctant and defensive. In the latter case, where the teachers were eased in slowly and led by interested administrators, there was spontaneous eagerness and limitless curiosity from within the faculty for more and more micros. How do I motivate? How to train? Rural school districts can benefit by working with a nearby university to share expertise in the form of workshops, courses and consultant relationships. Another problem: Buying software -- We are sure now that teachers in rural schools don't have time to do their own programming. The district will have to buy the software.

This may be a good reason for small districts to purchase networks for their micros. That way a district can share internally the software that it purchases. We have noticed also that rural schools tend to buy different brands of micros. The ones we are aware of are buying TRS-80s, mainly because of the large amount of courseware available. It no doubt has a lot to do with the districts proximity to vendors. There seems to be a gradual shift of literacy from outside to inside the district. The key to the smooth transition into micro usage seems to be the leadership.

The implications for education are:

1. Students need many different kinds of skills in order to make wise use of the computer.
2. Computers are changing the learning process
3. Learning will be living; not just what we do in school
4. The computer is an aid to instruction
5. It will not replace the teacher

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